

Phase II Engine Development: Development of a Heavy Duty 0.2g/bhp-h NOx Engine

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Outline

- Objective
- Technology
- Synergisms
- Partners
- Schedule
- Challenges



Project Objective

- Technology demonstration of advanced air/fuel handling mechanisms on a natural engine (11 Liter, 325 hp, 1250 lb-ft) with a three-way catalyst, variable geometry turbo and EGR, targeted at 0.2 g/bhp.hr NO_x and 0.01 g/bhp.hr particulate.



Technical Strategy

- Chemically Correct Combustion
 - No excess oxygen, can use TWC
- High EGR Rates
 - A diluent to lower temperatures
- Three Way Catalyst
 - High conversion efficiency
 - Proven automotive technology



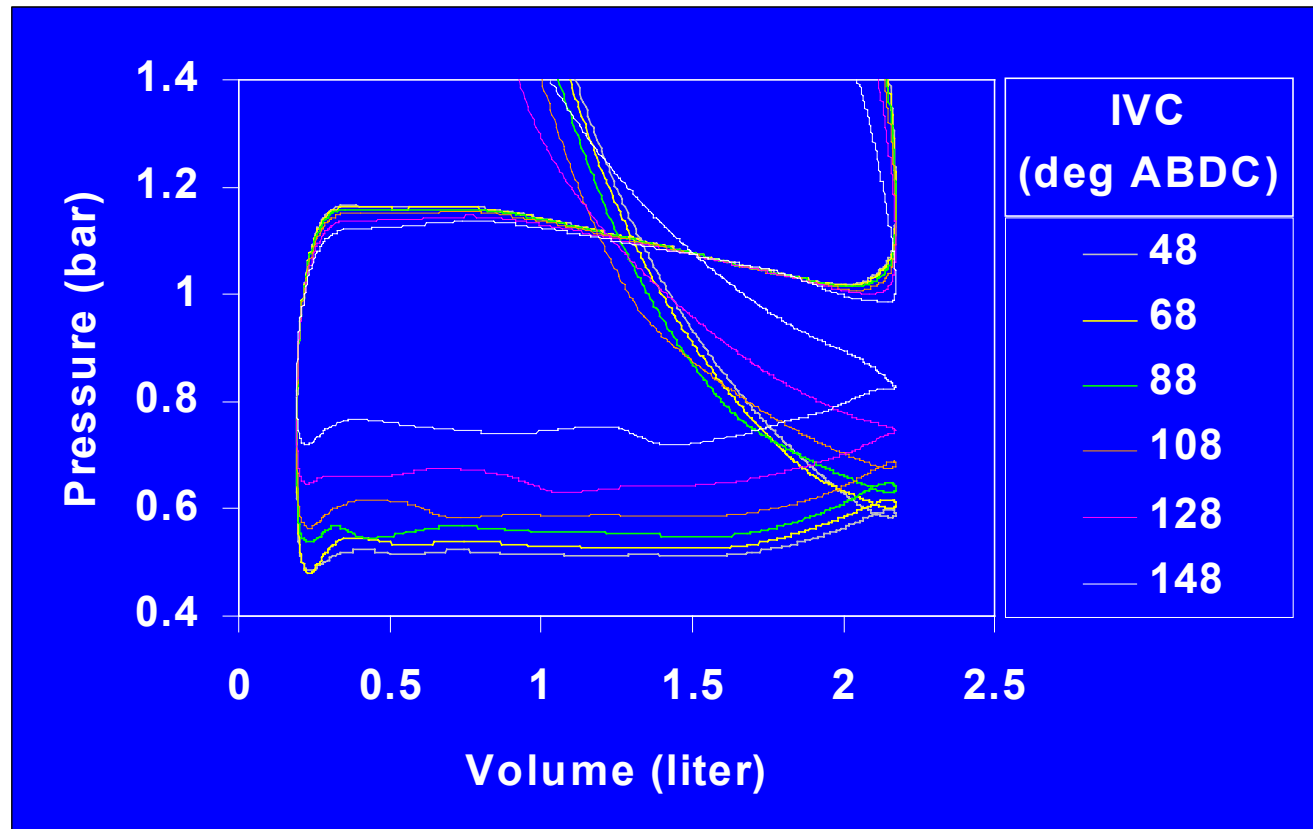
Technical Strategy

- Late Intake Valve Closing Reduces Pumping Losses
 - Volume of trapped charge is smaller with a later intake valve closing
 - Requires a larger throttle position to obtain the same power at the same equivalence ratio
 - Lower pressure drop across throttle
- Additional valve control strategies may allow complete removal of the throttle.



Late Intake Valve Closing Reduces Pumping Losses

- P-V Diagram, 1250 rpm, 15% load



Technical Strategy

- The combination of Miller cycle, internal EGR and external EGR helps emission reduction.
 - TDC temperature can be reduced by Miller cycle at partial loads
 - External EGR provides better BSFC/NO_x tradeoff, while internal EGR helps transient control with its cycle-to-cycle controllability.



The Mack Advantage

- This is part of a large corporative program that also includes our diesel product.
- Therefore, we can get state-of-the-art technology with relatively low cost.



Project Partners

- Subcontractor – Mack Trucks, Inc.
- Lower-Tier Subcontractors
 - Southwest Research Institute
 - Sturman Industries
 - Johnson-Matthey
 - Donaldson Company, Inc.
 - Gas Technology Institute



Planning Chart

Month	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
Incorporation of Design Elements																								
Pistons & Plugs from 9-liter																								
EGR hardware from 11-liter																								
VTG from 11-liter																								
Parts Design & Adaption																								
Design Pistons																								
Cyl Head Redesign																								
Misc Brackets etc.																								
Adaption of other parts																								
Make Prototype Parts & Assemble Prototype Engine																								
Heads																								
Pistons																								
Manifolds																								
Brackets, etc.																								
Sturman VVT System																								
Engine Assembly																								
Install Engine & RPECS & Conduct Testing																								
Engine Installation																								
Control System Installation																								
Engine Mapping																								
VVT Control																								
EGR & A/F Distribution, Measure & Improve																								
Catalyst Evaluation																								



Challenges

- Catalyst Degredation
 - Similar problems as with the automotive industry
- EGR System
 - Similar problems as with 2002 diesel engines
 - Transient control
- VVA System
 - Risks associated with this cutting-edge technology

